

YOU'RE HEARD, LOUD AND CLEAR.

**Instruction Manual
Vari-Notch® Cavity Filter
4" Diameter**

Manual Part Number

7-9150



Warranty

This warranty applies for one year from shipping date.

TX RX Systems Inc. warrants its products to be free from defect in material and workmanship at the time of shipment. Our obligation under warranty is limited to replacement or repair, at our option, of any such products that shall have been defective at the time of manufacture. **TX RX Systems Inc.** reserves the right to replace with merchandise of equal performance although not identical in every way to that originally sold. **TX RX Systems Inc.** is not liable for damage caused by lightning or other natural disasters. No product will be accepted for repair or replacement without our prior written approval. The purchaser must prepay all shipping charges on returned products. **TX RX Systems Inc.** shall in no event be liable for consequential damages, installation costs or expense of any nature resulting from the purchase or use of products, whether or not they are used in accordance with instructions. This warranty is in lieu of all other warranties, either expressed or implied, including any implied warranty or merchantability of fitness. No representative is authorized to assume for **TX RX Systems Inc.** any other liability or warranty than set forth above in connection with our products or services.

TERMS AND CONDITIONS OF SALE

PRICES AND TERMS:

Prices are FOB seller's plant in Angola, NY domestic packaging only, and are subject to change without notice. Federal, State and local sales or excise taxes are not included in prices. When Net 30 terms are applicable, payment is due within 30 days of invoice date. All orders are subject to a \$100.00 net minimum.

QUOTATIONS:

Only written quotations are valid.

ACCEPTANCE OF ORDERS:

Acceptance of orders is valid only when so acknowledged in writing by the seller.

SHIPPING:

Unless otherwise agreed at the time the order is placed, seller reserves the right to make partial shipments for which payment shall be made in accordance with seller's stated terms. Shipments are made with transportation charges collect unless otherwise specified by the buyer. Seller's best judgement will be used in routing, except that buyer's routing is used where practicable. The seller is not responsible for selection of most economical or timeliest routing.

CLAIMS:

All claims for damage or loss in transit must be made promptly by the buyer against the carrier. All claims for shortages must be made within 30 days after date of shipment of material from the seller's plant.

SPECIFICATION CHANGES OR MODIFICATIONS:

All designs and specifications of seller's products are subject to change without notice provided the changes or modifications do not affect performance.

RETURN MATERIAL:

Product or material may be returned for credit only after written authorization from the seller, as to which seller shall have sole discretion. In the event of such authorization, credit given shall not exceed 80 percent of the original purchase. In no case will Seller authorize return of material more than 90 days after shipment from Seller's plant. Credit for returned material is issued by the Seller only to the original purchaser.

ORDER CANCELLATION OR ALTERATION:

Cancellation or alteration of acknowledged orders by the buyer will be accepted only on terms that protect the seller against loss.

NON WARRANTY REPAIRS AND RETURN WORK:

Consult seller's plant for pricing. Buyer must prepay all transportation charges to seller's plant. Standard shipping policy set forth above shall apply with respect to return shipment from TX RX Systems Inc. to buyer.

DISCLAIMER

Product part numbering in photographs and drawings is accurate at time of printing. Part number labels on TX RX products supersede part numbers given within this manual. Information is subject to change without notice.



Manual Part Number 7-9150 Copyright © 2007 TX RX Systems, Inc. First Printing: October 1996	
Version Number	Version Date
1	10/18/96
2	07/19/07

Symbols Commonly Used



WARNING



ESD Electrostatic Discharge



CAUTION or ATTENTION



Hot Surface



High Voltage



Electrical Shock Hazard



Use Safety Glasses



Important Information



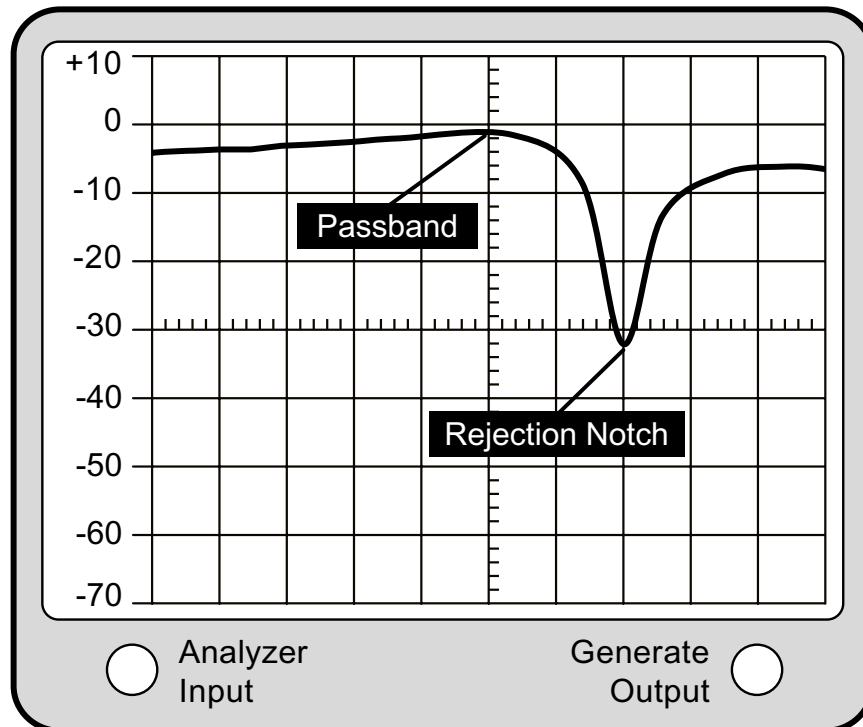


Figure 1: Spectrum Analyzer/Tracking Generator display of the lowpass 4" Vari-Notch filter.
Response curve shown for model number 15-52-01 (215-250 MHz)

GENERAL DESCRIPTION

The 4" Vari-Notch® cavity filter is designed to pass a relatively narrow band of frequencies (***passband***) while simultaneously rejecting a wide band of frequencies (***rejection notch***). A variety of models are available that cover the range of frequencies from 132 to 960 MHz. The portion of the frequency range that each model will tune across is determined by the cavity's physical length.

Two types of 4" Vari-Notch filters are available, lowpass and highpass. Lowpass filters have the passband below the notch frequency while highpass filters have the passband above the notch. The cavity itself remains identical for both types. **Figure 1** shows the response curve of a lowpass filter.

There are two adjustable parameters in a 4" Vari-Notch filter including the ***passband frequency*** and the ***rejection notch frequency***. Both of these parameters are labeled on the response curve shown in figure 1. All of the physical components of the filter are labeled in **Figure 2**, with the adjustable parts shown in ***emboldened italics***. The tuning rod is used to adjust the passband while a variable capacitor is used to adjust the rejection notch.

TUNING

Required Equipment

The following equipment or it's **equivalent** is recommended in order to properly perform the tuning adjustments for the 4" Vari-Notch filter.

1. IFR A-7550 Spectrum Analyzer with optional Tracking Generator installed.
2. Eagle Return Loss Bridge (model RLB150N3A).
3. Double shielded coaxial cable test leads (RG142 B/U or RG223/U).
4. 50 Ohm load, with at least -35 dB return loss (1.10:1 VSWR).
5. Insulated tuning tool (TX RX Systems Inc. part# 95-00-01).
6. 1/4" open-ended wrench.

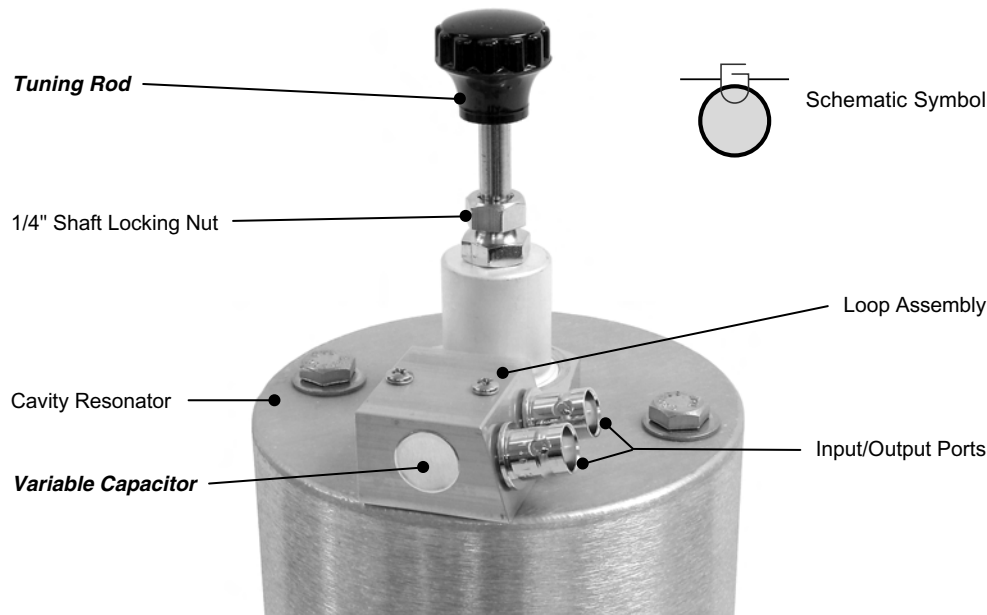


Figure 2: The 4" Vari-Notch filter.

Tuning Procedure

Tuning of the filter requires adjustment of the *passband* and the *rejection notch*. The passband is adjusted while observing the return loss response and the rejection notch is adjusted by monitoring the output of a tracking generator after it passes through the filter. To insure proper tuning of the 4" Vari-notch filter all adjustments should be performed in the following order:

1. Rough tune the passband.
2. Rough tune the notch.
3. Final tune the passband.
4. Final tune the notch, always the last adjustment made.

PASSBAND

The peak of the passband will correspond very closely to the point of minimum reflected energy from the filter and maximum forward power through it. A transmitter connected to the filter will operate best when the reflected energy is lowest, therefore the return loss response will be used to set the passband. The passband can be checked and adjusted using the following procedure.

Checking the passband

1. A zero reference for return loss must be established at the IFR A-7550 prior to checking the passband frequency, this is done by connecting the return loss bridge to the analyzer / generator as shown in **Figure 3**.
2. Set-up the analyzer / generator for the desired frequency (center of display) and for a vertical scale of 10 dB/div.
3. Do not connect the return loss bridge to the cavity, leave the "load" port on the bridge open. This will supply the maximum amount of reflected energy to the analyzer input.
4. Insure that the IFR A-7550 menu's are set as follows:
 - DISPLAY - line
 - MODE - live
 - FILTER - none
 - SETUP - 50 ohm/dBm/gen1.
5. The flat line across the screen is the return loss curve. Select the "Mode" main menu item and then choose the "Store " command.
6. Next select the "Display" main menu item and choose the "Reference" command. This will cause the stored value to be displayed at the center of the screen as the 0 dB reference value.

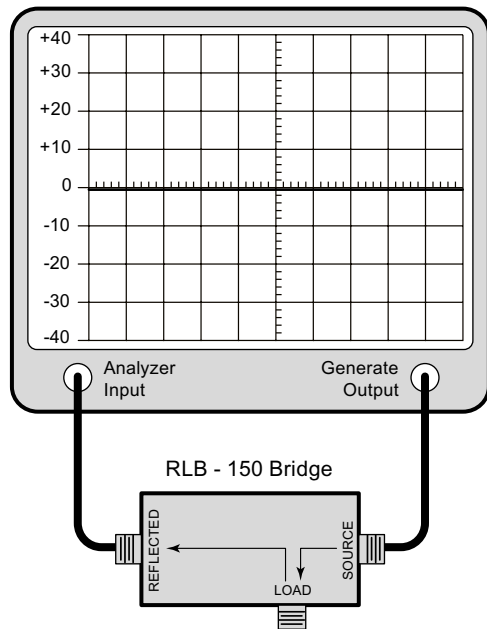


Figure 3: Setting the return loss reference.

7. Connect the "load" port on the RLB to one of the input /output ports and make sure the remaining port is connected to a 50 ohm load; refer to **Figure 4**. The display will now present the return loss curve for the 4" Vari-Notch filter being measured. **The passband is that frequency range over which the return loss is 15 dB or greater.**

The resonant frequency is adjusted by using the tuning rod, which is a sliding adjustment (invar rod) that rapidly tunes the response curve across the frequency range of the filter. Resonant frequency is increased by pulling the rod out of the cavity and is decreased by pushing the rod into the cavity. For ease in making adjustments, rotate and slide the rod while gently tapping on it with a screwdriver or other small tool. This will break the surface tension on the probe contact fingers and allow smoother movement of the tuning rod.

Once the desired response is obtained using the tuning rod, it is "locked" into place by tightening the 1/4" shaft lock nut. **Failure to lock the tuning rod** will cause a loss of temperature compensation and detuning of the cavity.

REJECTION NOTCH

The rejection notch will track with the tuning of the passband and therefore should be the last adjust-

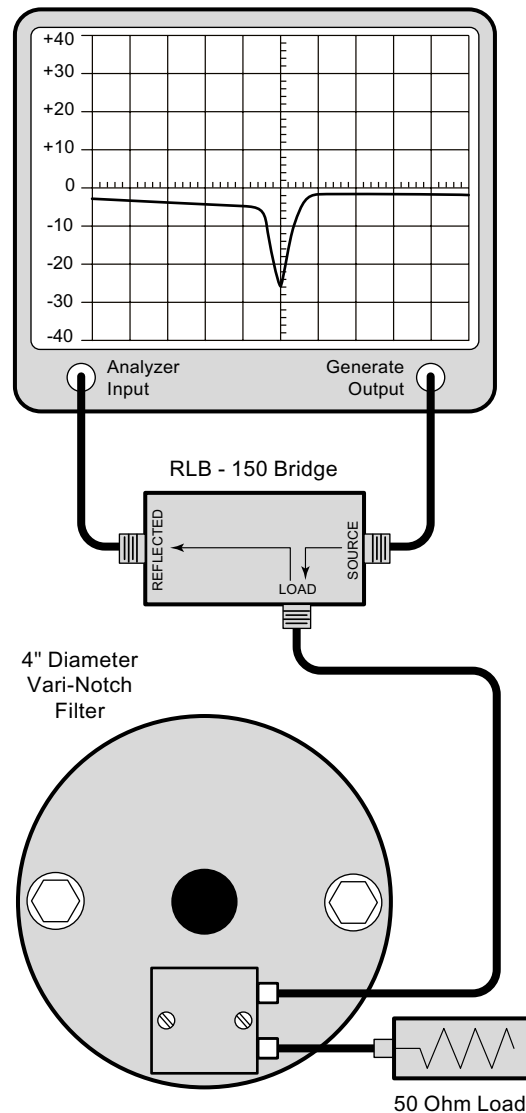


Figure 4: Checking the passband.

ment made to the 4" Vari-Notch filter. The rejection notch is adjusted by changing the amount of capacitance in the loop assembly. The capacitor is a variable tubular-piston type.

Checking the rejection notch

1. The rejection notch is checked by connecting the tracking generator to the input of the cavity filter while the spectrum analyzer is connected to the output, as illustrated in **Figure 5**.
2. Insure that the IFR A-7550 menu's are set as follows:
 - DISPLAY - line
 - MODE - live
 - FILTER - none
 - SETUP - 50 ohm/dBm/gen1.

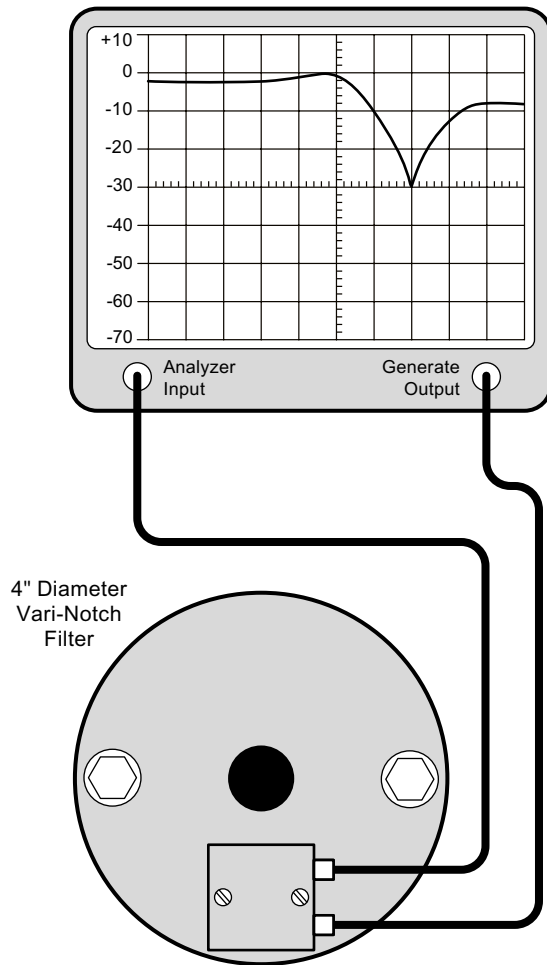


Figure 5: Checking the

Adjusting the rejection notch

The notch is adjusted by turning the variable capacitor. Because of the filters sensitivity to tool contact, an insulated tuning tool must be used to make the adjustment. Access to the capacitor is obtained by removing the silver dot, small screw or rubber button on the side of the loop assembly.

MULTIPLE CAVITY VARI-NOTCH FILTERS

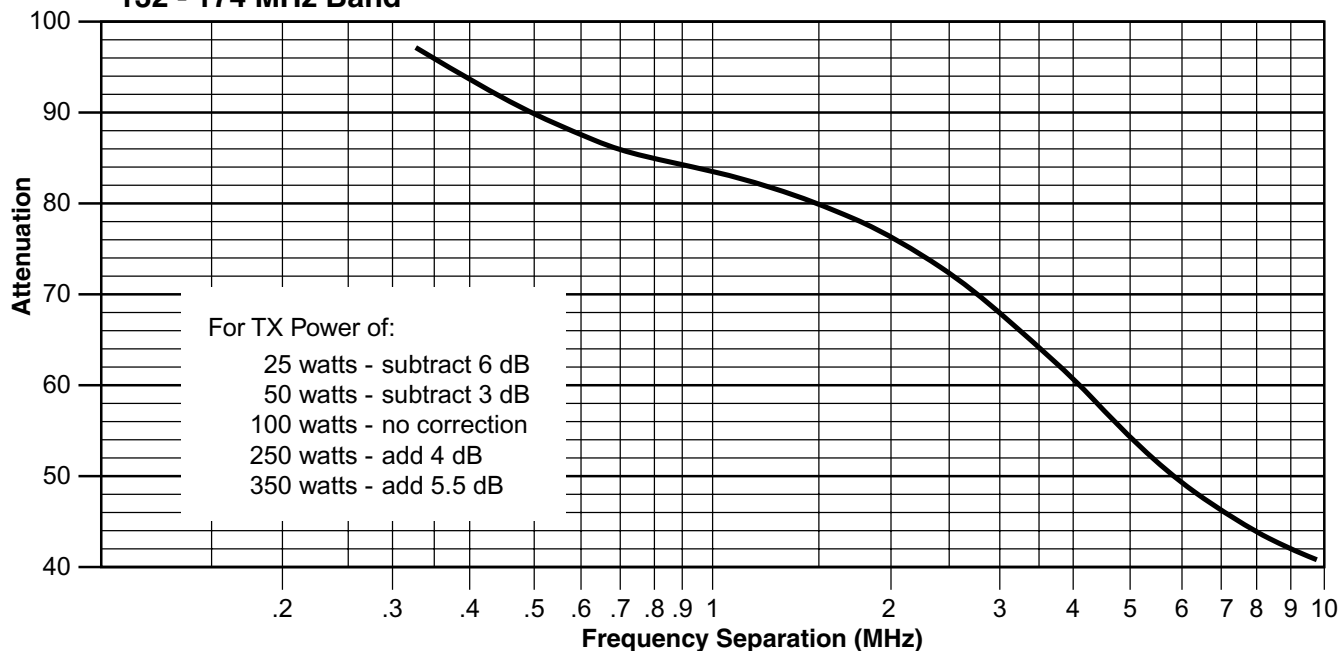
Vari-Notch filters can be ordered in multiple cavity arrangements of either two or three combined cavities. In these arrangements, identical filters are connected in a cascaded fashion with the output of each filter fed to the input port of the succeeding filter. The advantage to this arrangement is that the amount of attenuation provided by each of the filters is additive. In the case of the rejection notch frequency, the dual cavity can provide attenuation of over 60 dB (30 dB for each filter).

Also, the interconnecting cable between the two filters, when cut to the correct length (odd multiple of a $1/4 \lambda$), will provide up to 6 dB of additional attenuation due to a mismatch of impedance between the cable and the filters. The 6 dB of mismatch attenuation does not occur at the filters passband but, only at frequencies where moderate to high attenuation occurs, such as at the rejection notch frequency. Because each of the filters in the multi-cavity arrangement are identical, the passband for the entire arrangement is generally the same as the passband for the individual filters. However, each filters individual insertion loss is also additive. When tuning a multi-cavity arrangement, each filter is tuned individually prior to interconnecting them. Then each is fine tuned to peak the overall response of the multi-cavity arrangement.

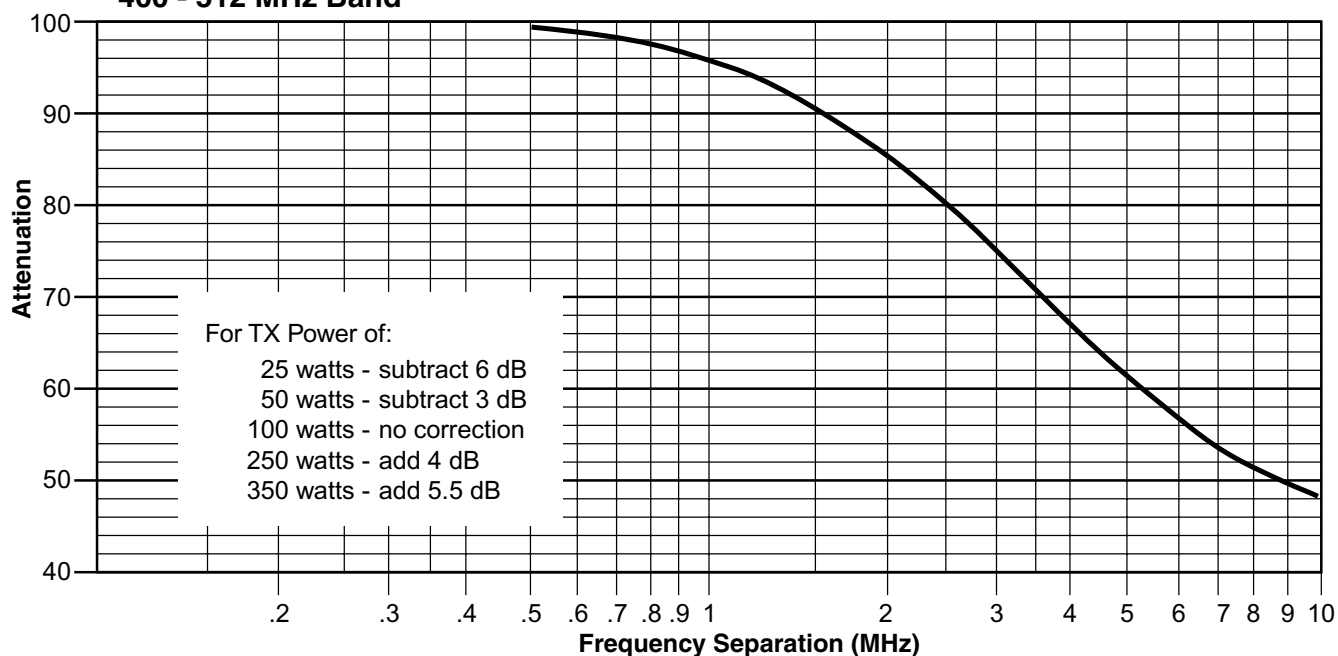
Isolation Curves for Transmitter/Receiver

The curves shown below for use with filters, duplexers, and multicouplers, indicate the amount of isolation or attenuation required between a typical 100 watt transmitter and its associated receiver at the TX (carrier suppression) and RX (noise suppression) frequency which will result in no more than a 1 dB degradation of the 12 dB SINAD sensitivity.

132 - 174 MHz Band



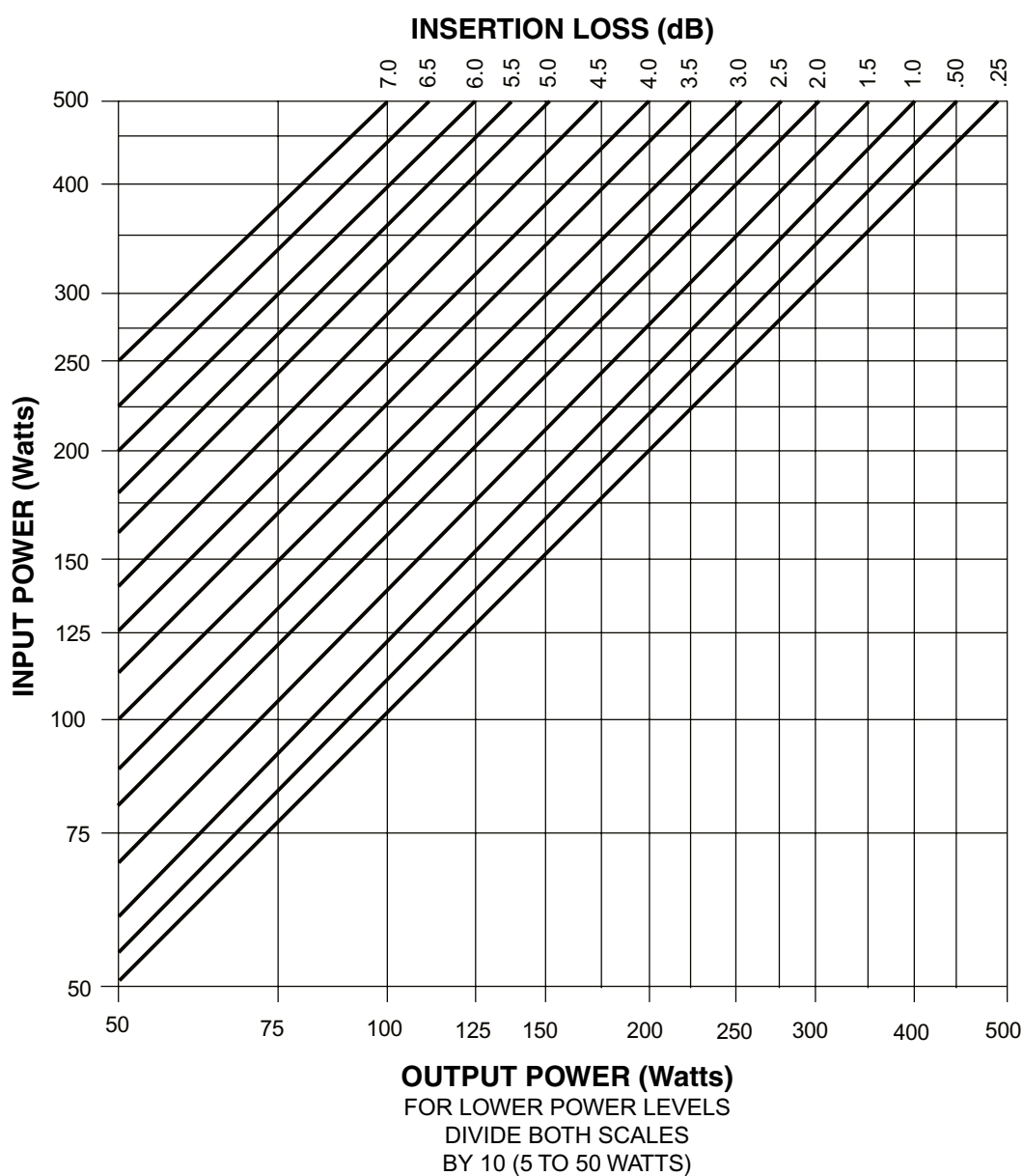
400 - 512 MHz Band



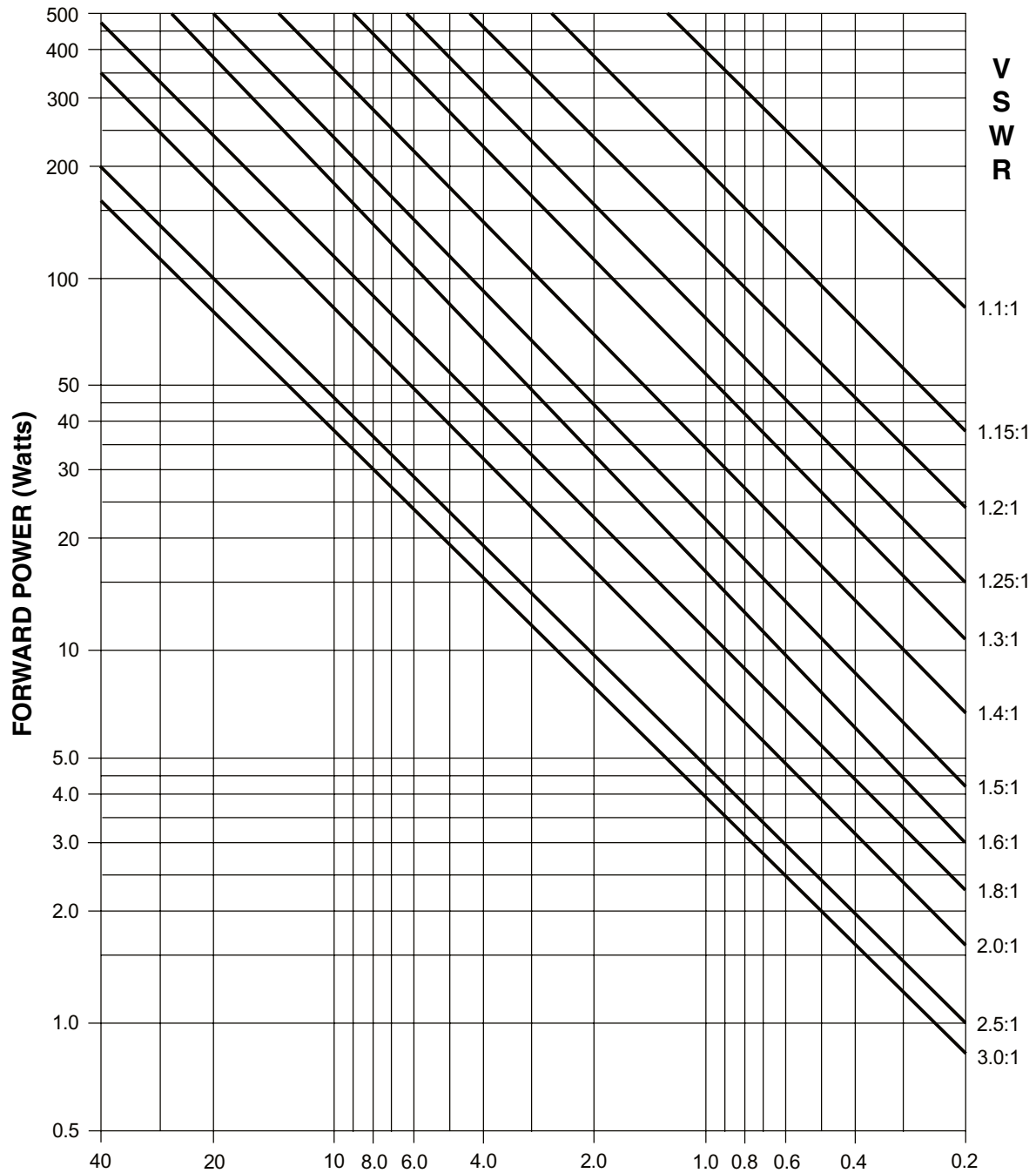
These are only "typical" curves. When accuracy is required, consult the radio manufacturer.

POWER IN/OUT VS INSERTION LOSS

The graph below offers a convenient means of determining the insertion loss of filters, duplexers, multicouplers and related products. The graph on the back page will allow you to quickly determine VSWR. It should be remembered that the field accuracy of wattmeter readings is subject to considerable variance due to RF connector VSWR and basic wattmeter accuracy, particularly at low end scale readings. However, allowing for these variances, these graphs should prove to be a useful reference.



POWER FWD./REV. VS VSWR



REFLECTED POWER (Watts)

FOR OTHER POWER LEVELS
MULTIPLY BOTH SCALES
BY THE SAME MULTIPLIER

Power Ratio and Voltage Ratio to Decibel Conversion Chart

Loss or Gain	Power Ratio	Voltage Ratio
+9.1 dB	8.128	2.851
-9.1 dB	0.123	0.351

← - dB + →

← - dB + →

Voltage Ratio	Power Ratio	dB	Voltage Ratio	Power Ratio
1	1	0	1	1
0.989	0.977	0.1	1.012	1.023
0.977	0.955	0.2	1.023	1.047
0.966	0.933	0.3	1.035	1.072
0.955	0.912	0.4	1.047	1.096
0.944	0.891	0.5	1.059	1.122
0.933	0.871	0.6	1.072	1.148
0.923	0.851	0.7	1.084	1.175
0.912	0.832	0.8	1.096	1.202
0.902	0.813	0.9	1.109	1.23
0.891	0.794	1	1.122	1.259
0.881	0.776	1.1	1.135	1.288
0.871	0.759	1.2	1.148	1.318
0.861	0.741	1.3	1.161	1.349
0.851	0.724	1.4	1.175	1.38
0.841	0.708	1.5	1.189	1.413
0.832	0.692	1.6	1.202	1.445
0.822	0.676	1.7	1.216	1.479
0.813	0.661	1.8	1.23	1.514
0.804	0.646	1.9	1.245	1.549
0.794	0.631	2	1.259	1.585
0.785	0.617	2.1	1.274	1.622
0.776	0.603	2.2	1.288	1.66
0.767	0.589	2.3	1.303	1.698
0.759	0.575	2.4	1.318	1.738
0.75	0.562	2.5	1.334	1.778
0.741	0.55	2.6	1.349	1.82
0.733	0.537	2.7	1.365	1.862
0.724	0.525	2.8	1.38	1.905
0.716	0.513	2.9	1.396	1.95
0.708	0.501	3	1.413	1.995
0.7	0.49	3.1	1.429	2.042
0.692	0.479	3.2	1.445	2.089
0.684	0.468	3.3	1.462	2.138
0.676	0.457	3.4	1.479	2.188
0.668	0.447	3.5	1.496	2.239
0.661	0.437	3.6	1.514	2.291
0.653	0.427	3.7	1.531	2.344
0.646	0.417	3.8	1.549	2.399
0.638	0.407	3.9	1.567	2.455
0.631	0.398	4	1.585	2.512
0.624	0.389	4.1	1.603	2.57
0.617	0.38	4.2	1.622	2.63
0.61	0.372	4.3	1.641	2.692
0.603	0.363	4.4	1.66	2.754
0.596	0.355	4.5	1.679	2.818
0.589	0.347	4.6	1.698	2.884
0.582	0.339	4.7	1.718	2.951
0.575	0.331	4.8	1.738	3.02
0.569	0.324	4.9	1.758	3.09

Voltage Ratio	Power Ratio	dB	Voltage Ratio	Power Ratio
0.562	0.316	5	1.778	3.162
0.556	0.309	5.1	1.799	3.236
0.55	0.302	5.2	1.82	3.311
0.543	0.295	5.3	1.841	3.388
0.537	0.288	5.4	1.862	3.467
0.531	0.282	5.5	1.884	3.548
0.525	0.275	5.6	1.905	3.631
0.519	0.269	5.7	1.928	3.715
0.513	0.263	5.8	1.95	3.802
0.507	0.257	5.9	1.972	3.89
0.501	0.251	6	1.995	3.981
0.496	0.246	6.1	2.018	4.074
0.49	0.24	6.2	2.042	4.169
0.484	0.234	6.3	2.065	4.266
0.479	0.229	6.4	2.089	4.365
0.473	0.224	6.5	2.113	4.467
0.468	0.219	6.6	2.138	4.571
0.462	0.214	6.7	2.163	4.677
0.457	0.209	6.8	2.188	4.786
0.452	0.204	6.9	2.213	4.898
0.447	0.2	7	2.239	5.012
0.442	0.195	7.1	2.265	5.129
0.437	0.191	7.2	2.291	5.248
0.432	0.186	7.3	2.317	5.37
0.427	0.182	7.4	2.344	5.495
0.422	0.178	7.5	2.371	5.623
0.417	0.174	7.6	2.399	5.754
0.412	0.17	7.7	2.427	5.888
0.407	0.166	7.8	2.455	6.026
0.403	0.162	7.9	2.483	6.166
0.398	0.159	8	2.512	6.31
0.394	0.155	8.1	2.541	6.457
0.389	0.151	8.2	2.57	6.607
0.385	0.148	8.3	2.6	6.761
0.38	0.145	8.4	2.63	6.918
0.376	0.141	8.5	2.661	7.079
0.372	0.138	8.6	2.692	7.244
0.367	0.135	8.7	2.723	7.413
0.363	0.132	8.8	2.754	7.586
0.359	0.129	8.9	2.786	7.762
0.355	0.126	9	2.818	7.943
0.351	0.123	9.1	2.851	8.128
0.347	0.12	9.2	2.884	8.318
0.343	0.118	9.3	2.917	8.511
0.339	0.115	9.4	2.951	8.71
0.335	0.112	9.5	2.985	8.913
0.331	0.11	9.6	3.02	9.12
0.327	0.107	9.7	3.055	9.333
0.324	0.105	9.8	3.09	9.55
0.32	0.102	9.9	3.126	9.772

Power Conversion Chart

dBm to dBw to Watts to Volts

dBm	dBw	Watts	Volts 50Ω
80	50	100kW	2236
75	45	31.6 kW	1257
70	40	10.0 kW	707
65	35	3.16 kW	398
60	30	1000	224
55	25	316	126
50	20	100	70.7
45	15	31.6	39.8
40	10	10.0	22.4
38	8	6.31	17.8
36	6	3.98	14.1
34	4	2.51	11.2
32	2	1.58	8.90
30	0	1.00	7.07
29	-1	0.79	6.30
28	-2	0.63	5.62
27	-3	0.50	5.01
26	-4	0.40	4.46
25	-5	0.32	3.98
24	-6	0.25	3.54
23	-7	0.20	3.16
22	-8	0.16	2.82
21	-9	0.13	2.51
20	-10	0.10	2.24
19	-11	79 mW	1.99

dBm	dBw	Watts	Volts 50Ω
18	-12	63 mW	1.78
17	-13	50 mW	1.58
16	-14	40 mW	1.41
15	-15	32 mW	1.26
14	-16	25 mW	1.12
13	-17	20 mW	1.00
12	-18	16 mW	0.890
11	-19	13 mW	0.793
10	-20	10 mW	0.707
9	-21	7.9 mW	0.630
8	-22	6.3 mW	0.562
7	-23	5.0 mW	0.501
6	-24	4.0 mW	0.446
5	-25	3.2 mW	0.398
4	-26	2.5 mW	0.354
3	-27	2.0 mW	0.316
2	-28	1.6 mW	0.282
1	-29	1.3 mW	0.251
0	-30	1.0 mW	0.224
-5	-35	316 uW	0.126
-10	-40	100 uW	0.071
-15	-45	31.6 uW	0.040
-20	-50	10 uW	0.022
-25	-55	3.16 uW	0.013
-30	-60	1 uW	0.007

Free Space Path Loss Estimator

	Frequency in MHz							
	50	150	170	450	500	800	900	
Path Length (miles)	0.1	50.58	60.12	61.21	69.66	70.58	74.66	75.68
	0.25	58.54	68.08	69.17	77.62	78.54	82.62	83.64
	0.5	64.56	74.10	75.19	83.64	84.56	88.64	89.66
	1	70.58	80.12	81.21	89.66	90.58	94.66	95.68
	2	76.60	86.14	87.23	95.68	96.60	100.68	101.71
	3	80.12	89.66	90.75	99.21	100.12	104.20	105.23
	4	82.62	92.16	93.25	101.71	102.62	106.70	107.73
	5	84.56	94.10	95.19	103.64	104.56	108.64	109.66
	6	86.14	95.68	96.77	105.23	106.14	110.22	111.25
	7	87.48	97.02	98.11	106.57	107.48	111.56	112.59
	8	88.64	98.18	99.27	107.73	108.64	112.72	113.75
	9	89.66	99.21	100.29	108.75	109.66	113.75	114.77
	10	90.58	100.12	101.21	109.66	110.58	114.66	115.68
	12	92.16	101.71	102.79	111.25	112.16	116.25	117.27
	14	93.50	103.04	104.13	112.59	113.50	117.58	118.61
	16	94.66	104.20	105.29	113.75	114.66	118.74	119.77
	18	95.68	105.23	106.31	114.77	115.68	119.77	120.79
	20	96.60	106.14	107.23	115.68	116.60	120.68	121.71
	30	100.12	109.66	110.75	119.21	120.12	124.20	125.23
	40	102.62	112.16	113.25	121.71	122.62	126.70	127.73
	50	104.56	114.10	115.19	123.64	124.56	128.64	129.66

Formula: Path Loss (dB) = 36.6 + 20 log (MHz) + 20 log (miles)

Return Loss vs. VSWR

Return Loss	VSWR
30	1.06
25	1.11
20	1.20
19	1.25
18	1.28
17	1.33
16	1.37
15	1.43
14	1.50
13	1.57
12	1.67
11	1.78
10	1.92
9	2.10

Watts to dBm

Watts	dBm
300	54.8
250	54.0
200	53.0
150	51.8
100	50.0
75	48.8
50	47.0
25	44.0
20	43.0
15	41.8
10	40.0
5	37.0
4	36.0
3	34.8
2	33.0
1	30.0

dBm = 10log P/1mW
Where P = power (Watt)

Insertion Loss

Input Power (Watts)

		50	75	100	125	150	200	250	300
Insertion Loss	3	25	38	50	63	75	100	125	150
	2.5	28	42	56	70	84	112	141	169
	2	32	47	63	79	95	126	158	189
	1.5	35	53	71	88	106	142	177	212
	1	40	60	79	99	119	159	199	238
	.5	45	67	89	111	134	178	223	267

Output Power (Watts)

Free Space Loss

Distance (miles)

	.25	.50	.75	1	2	5	10	15
Frequency (MHz)	150	68	74	78	80	86	94	104
	220	71	77	81	83	89	97	107
	460	78	84	87	90	96	104	113
	860	83	89	93	95	101	109	119
	940	84	90	94	96	102	110	120
	1920	90	96	100	102	108	116	126

Free Space Loss (dB)

Free space loss = 36.6 + 20log D + 20log F
Where D = distance in miles and F = frequency in MHz



